

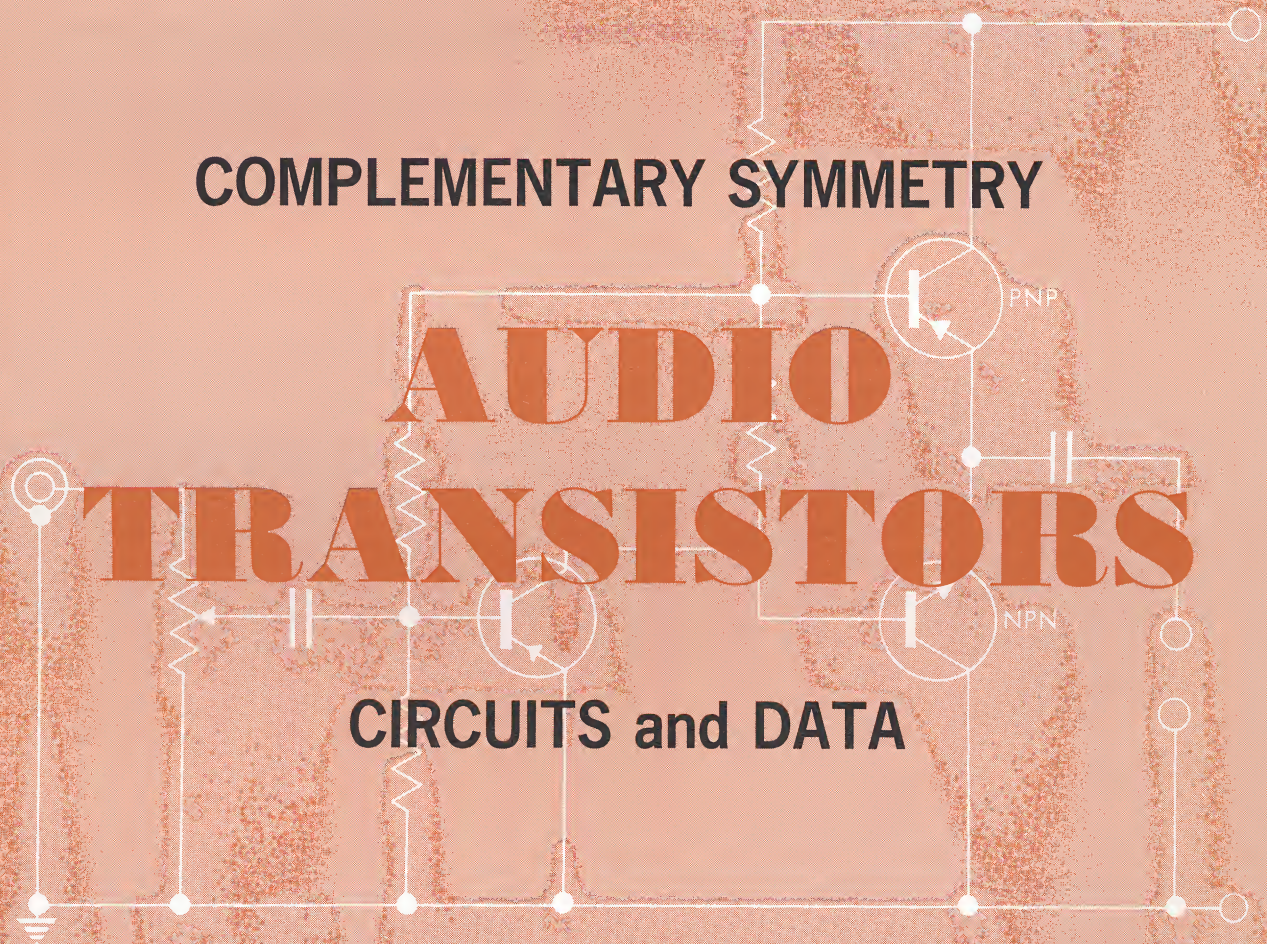


Amperex®

COMPLEMENTARY SYMMETRY

AUDIO TRANSISTORS

CIRCUITS and DATA

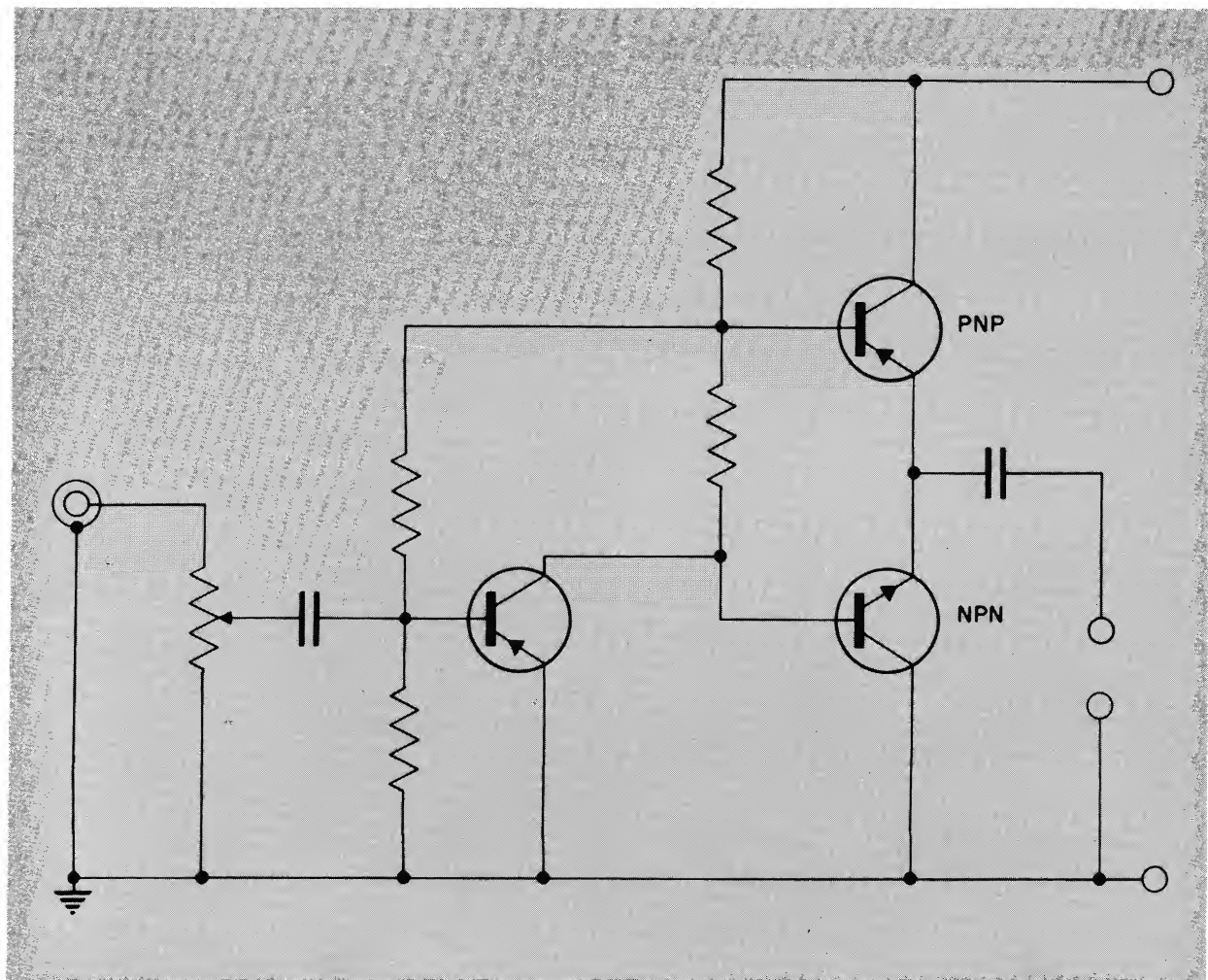


ELECTRON TUBES • SEMICONDUCTORS • COMPONENTS

AMPEREX ELECTRONIC CORPORATION
SEMICONDUCTOR AND RECEIVING TUBE DIVISION

SLATERSVILLE, RHODE ISLAND 02876 • 401/POplar 2-9000

**Is complementary symmetry
the only way
to sell audio transistors
today?**

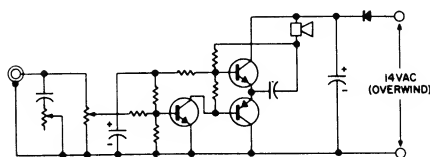


You bet it is!

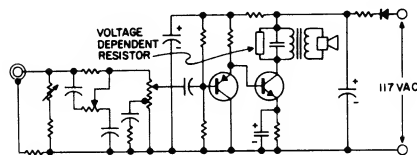
Complementary Symmetry is the ultimate in economical, reliable circuitry for audio applications up to 12 watts.

FOR PHONOS (1 to 5 WATTS)

Complementary Symmetry achieves enormous manufacturing savings with no sacrifice in reliability, by using transistors as they should be used—as low voltage, low impedance, low temperature devices for Class B push-pull, instead of high voltage, high impedance (Class A) with transformers and associated components and high temperatures.



THE AMPEREX WAY



THE OLD WAY

Low voltage eliminates need for bottom plates, interlocks, etc. **Low temperatures** mean longer, more reliable component life. **Simple mounting clip** eliminates need for expensive heat sinks, mica insulating washers and mounting hardware. **No output transformers or VDR's**... low

output impedance of emitter follower output circuit obsoletes impedance-matching output transformer and related voltage dependent resistors.

Complementary Symmetry is not a new audio engineering approach! It has long been an audio designer's dream—a textbook approach! What is new, is that Amperex now provides the tools to make the textbook dream come true. We have the matched, paired transistors, dual heat-sinks, simplified circuits and application reports. Our applications department is at your service... and where required, complete breadboarded prototypes will be provided.

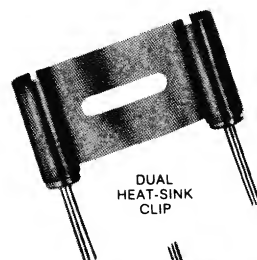
2N2707 matched pair 2N2430 (NPN) and 2N2706 (PNP) for power up to one watt for low cost phonos, amplifiers and radio; TO-1 cases in dual heat-sink clip.

2N4136 matched pair 2N2430 (NPN) and 2N2431 (PNP) for power up to 2.5 watts; TO-1 cases in dual heat-sink clip.

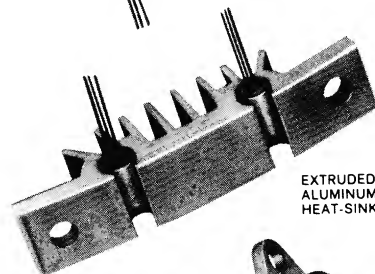
2N4107 matched pair 2N4105 (NPN) and 2N4106 (PNP) for power up to 7 watts; TO-1 cases in extruded aluminum heat-sink.

2N4079 matched pair 2N4077 (NPN) and 2N4078 (PNP) for power up to 12 watts; TO-3 cases.

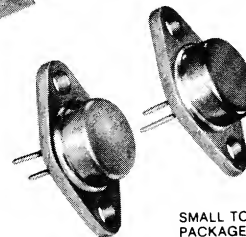
FOR AUTO RADIO OUTPUTS
(5 watts at 13.6 volts)
THE NEW 2N4079 PAIR
IS IDEALLY SUITED



DUAL HEAT-SINK CLIP



EXTRUDED ALUMINUM HEAT-SINK



SMALL TO-3 PACKAGE

Amperex®

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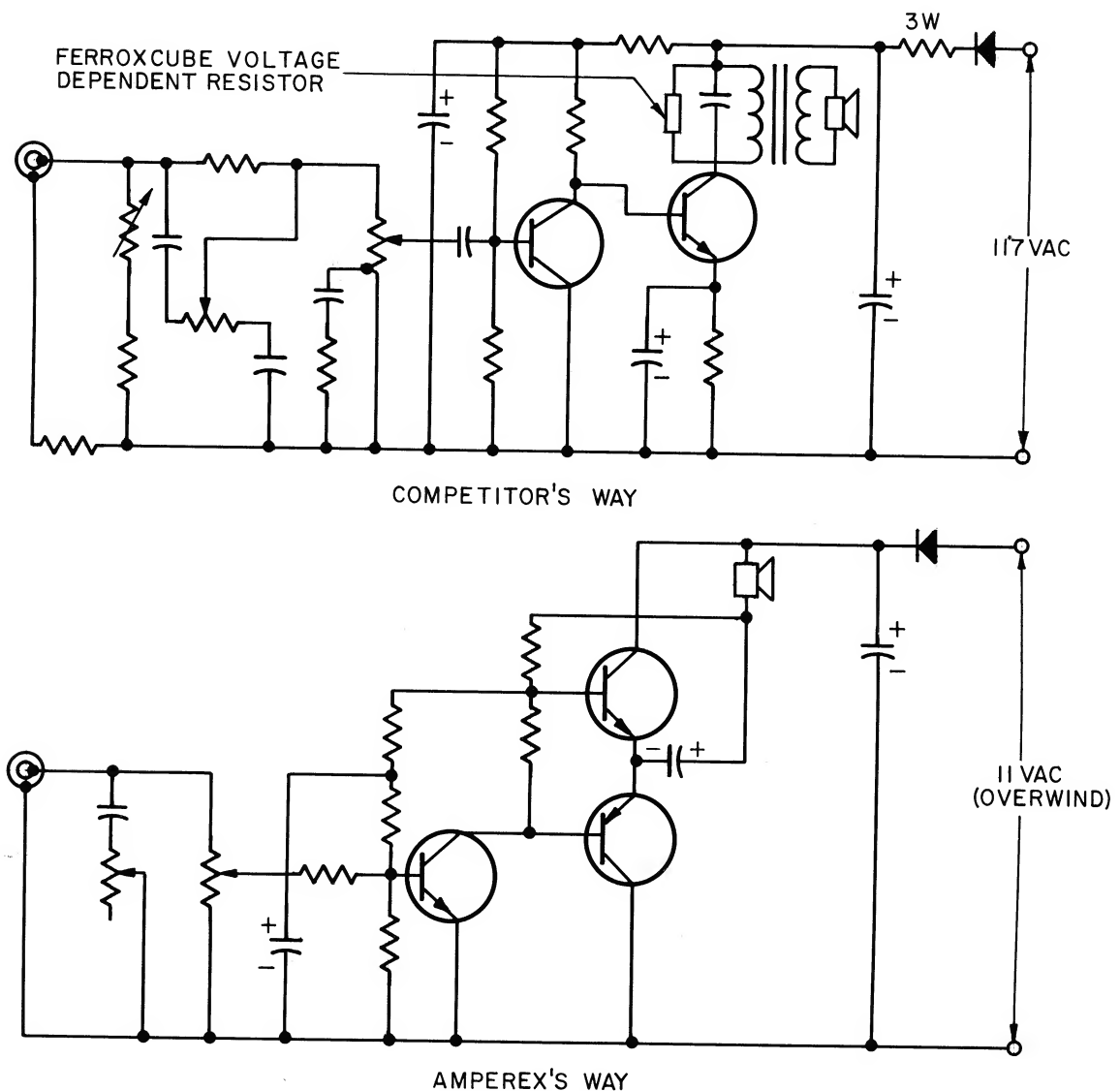
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AMPEREX AUDIO

The basic Amperex philosophy for audio has been to use transistors as transistors should be used - as low voltage, low impedance, low temperature devices (in Class B push-pull), rather than Class A high voltage, high impedance (with output transformers) and high temperatures.

As an example, let us compare the Amperex 1 Watt Audio Amplifier with a competitive 1 Watt Audio Amplifier.

COMPARISON OF AMPEREX AND A COMPETITIVE ONE WATT PHONO



AMPEREX ADVANTAGES:

1. Low voltage - provides substantial U. L. cost savings, since voltages lower than 30 do not require bottom plates, interlocks, etc.
2. Low temperatures - because of low idling currents in Class B configuration (total 10 ma at 14 volts = 140 milli-watts) compared to 2.5 to 4 watts in the Class A circuit. No heat means long component life - the real reason for using transistors in the first place! Switch from "hot" to "cools"!
3. Simple heat sink - since all electrodes of our TO-1 transistors are insulated from the case, and since there is relatively little heat generated, our dual clip holding the output pair can be conveniently riveted to a small tern-plate strip or control bracket eliminating the need for expensive, low thermal resistance heat sinks, mica insulating washers and mounting hardware.
4. No costly output transformers or VDR's - because of the low output impedance of our complementary output circuit, making impedance matching output transformers obsolete (similar to transistorized Hi-Fi equipment). Eliminating the output transformer eliminates the need for Voltage Dependent Resistors to protect the output transistor against transients, which can punch through and destroy the output device.

The use of a low voltage overwind (secondary winding) on a phono motor or clock motor provides complete isolation from the power line (as with a power transformer) for U.L. requirements and cost savings.

CLASS B "ACROSS THE BOARD"

This basic Class B philosophy extends from the 1 watt level up through 50 watts RMS.

TRANSISTOR TYPE	POWER OUT	VOICE COIL	SUPPLY VOLTAGE
2N2707	1 W	8	10 V
2N4136	2-1/4 W	8	15 V
2N4107	5 W	8	20 V
2N4107 in HS-3	8 W	8	24 V
2N4079	12 W	8	28 V

For car radio application

2N4079	5 W	3.2	13.6 V
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QUASI-COMPLEMENTARY SYMMETRY

2N4078 (MP)	12 W	8	26 V
2N2836/4241 (MP)	20 W	8	42 V
AD158 (Diffused Base) (MP)	25 W	8	46 V

(MP) - Matched Pairs

SINGLE-ENDED PUSH-PULL

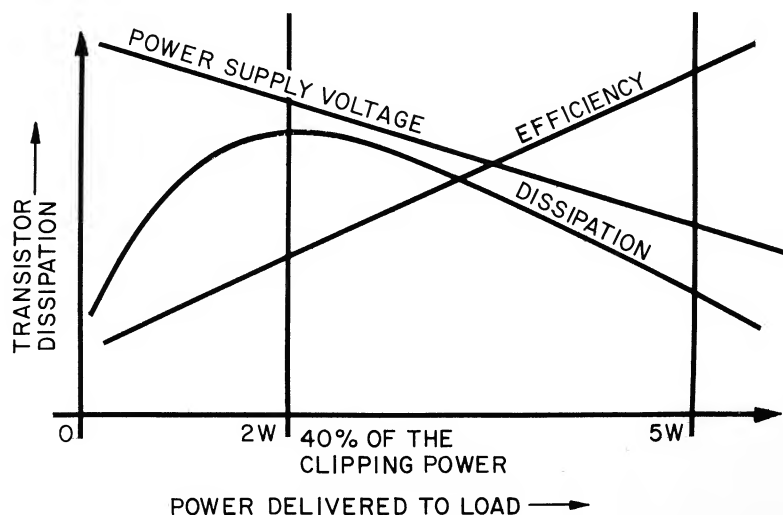
2N2431 (MP)	8 W	8	24 V
2N4078 (MP)	12 W	8	28 V
2N2836/4241 (MP)	25 W	8	42 V
AD158 (MP)	25 W	8	42 V

(MP) - Matched Pairs

Making 5 watts RMS with our TO-1 matched pairs is really no problem for engineers who are familiar with Class B transistor circuitry. Proper attention must be paid to power supply regulation and heat sink requirements. In Class B circuits it is more difficult to deliver 2 watts in a 5 watt amplifier than it is to deliver 5 watts! This paradox arises because of:

- A.) The difference in circuit efficiency at 5 watts as compared to 2 watts and
- B.) The rise in supply voltage because of power supply regulation at the 2 watt level.

If we were to plot transistor dissipation as a function of power delivered to the load, we would get the classical Class B curve as illustrated below:



You will notice that maximum dissipation within the transistor occurs at a power output level of approximately 40% of the maximum power output. At this point the circuit efficiency may be down to 50% (compared to 70% at the 10% distortion level). In addition, since we are drawing less current from the power supply, the voltage rises further increasing the transistor dissipation. If we were to drive the output transistors harder, the distortion would increase to the point where we would approach square wave output and the switching mode. At this point the power supply voltage would be at a minimum, the circuit could easily operate at 90% efficiency and the transistor dissipation would be at a minimum. Therefore, a 5 watt amplifier using TO-1's would be no problem, providing the supply is adequately regulated to limit the dissipation at the 2 watt level and adequate precautions are taken to provide thermal stability through the use of proper heat sinks, emitter resistors, and transistor temperature compensation.

THERMAL STABILITY

Workable equations for Class B thermal stability just don't seem to exist, either they are too complex to be useable or they don't really accommodate all the possible variables. The position of the heat sink, its proximity to another source of heat, heat pocketing in the cabinet, etc., are some of the factors that are usually omitted from the calculations. These all affect the thermal resistance of the heat sink and are important in the final evaluation of overall thermal stability.

A PRACTICAL PROCEDURE FOR ASSURING THERMAL STABILITY IN CLASS B CIRCUITS

First off, be aware of those factors which affect thermal stability during the design phase and help yourself wherever you can. For example:

- a. Use the largest emitter resistance the circuit can tolerate.
- b. Use the stiffest bias network with the lowest possible D.C. resistance from the base back to the emitter. (Or base to base resistor in complementary circuits).
- c. Resist the temptation to use the highest beta devices in the output stages. They may be easier to drive, but they aggravate the thermal stability problem by multiplying temperature sensitive leakage currents.
- d. Choose devices with low leakage at high temperatures. Remember, beta and leakage increase with temperature.
- e. Use the maximum heat sink available (consistent with the economics of the amplifier). Don't mount output transistors in heat pockets.
- f. Don't use any more power supply than necessary to deliver the required power.

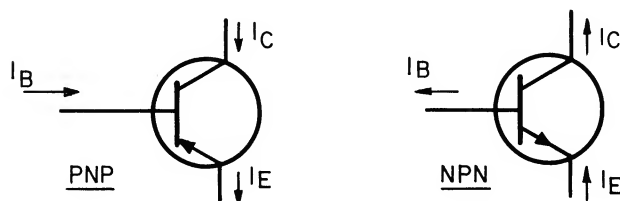
Once the design objectives (performance) have been achieved, the circuit should be checked out under worst case conditions as follows:

- a. Install high beta-limit transistors.
- b. Apply 10% higher line voltage.
- c. Put set in oven at highest ambient temperature it may encounter in actual service in final enclosure. Bring out leads so that the collector current can be monitored.
- d. Attach thermocouple to read transistor case temperature.
- e. Record "no signal" idling current after it stabilizes at highest ambient temperature.
- f. Drive amplifier to 40% of its rated output until the case temperature stabilizes and record temperature. Read I_c and V_{ce} of output transistors and calculate dissipation. Using thermal resistance on data sheet and transistor case temperature, calculate junction temperature and check that it doesn't exceed maximum continuous junction temperature as specified on data sheet.
- g. Remove drive signal and note the new "no signal" idling current drops back. This rate of drop is directly related to the thermal stability of the complete package. The faster it drops, the better the stability. A circuit that is not stable will exhibit a continuously rising current which will quickly go into thermal runaway. Using a sine wave signal at 40% of rated output subjects the amplifier to a transistor heat rise and dissipation that is approximately 20% greater than that which would normally be encountered with typical "music waveform" signals.

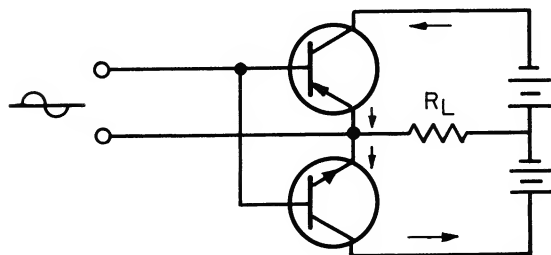
AMPEREX COMPLEMENTARY SYMMETRY DESIGNS

Due to the present copper shortage, production of audio amplifiers becomes a problem when audio output or driver transformers are used. With Amperex complementary symmetry designs both transformers are eliminated to achieve better performance, with lower cost and smaller size.

Basic complementary symmetry circuits use a PNP and a NPN transistor as the output pair. The electron current flow of the two transistors are opposite one another as indicated:



The two transistors are connected in series (as shown below) to permit a single ended stage to drive them as a Class B single-ended push-pull output. Each output transistor conducts during one half of each cycle.



A typical complementary symmetry (D.C. coupled) circuit is shown (PCA-1 - see diagram).

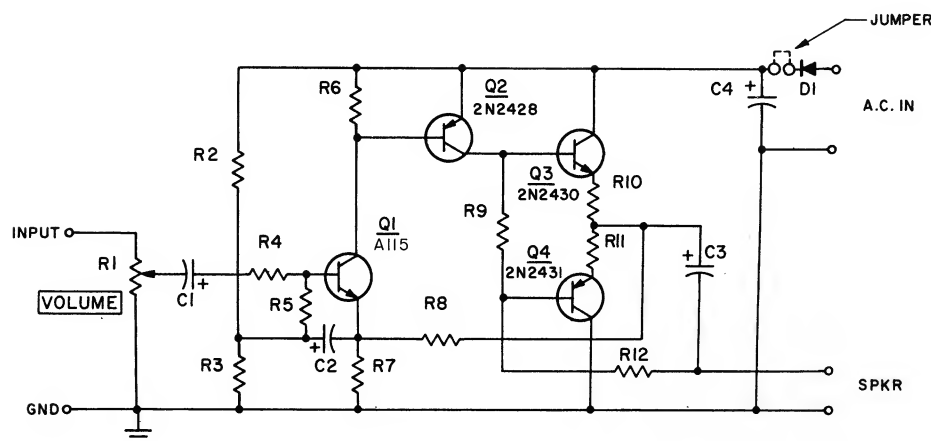
This circuit consists of a complementary push-pull output stage, a PNP driver stage and a NPN pre-amplifier stage. The features of the design are the economy effected in the number of components required, and the extremely good stability of the D.C. potential between Q3 and Q4, giving little variation of output with temperature changes.

The load is capacitively coupled to the emitters in the normal way, the bases being driven directly from the collector of Q2. The collector load of Q2 (R12) is returned to the emitters of the output transistors so that the output transistors are driven as a common emitter stage, instead of a common collector stage.

A small quiescent bias voltage is required for transistors operating in Class B push-pull. This is developed by the collector current of Q2 flowing through R9. R9 is very small compared to the R12.

The transistor Q1 serves a dual purpose. It acts as a preamplifier for A.C. signals and also as a D.C. difference amplifier. A voltage derived from the potential divider R2 and R3 is compared with the mid-point voltage between Q3 and Q4. The high D.C. loop gain of the circuit keeps the mid-point voltage between Q3 and Q4 constant, irrespective of spreads in the characteristics of the transistors Q1 and Q2 and the tolerance variations in the values of R5, R6, R12 and R4.

Negative feedback is taken via the resistor R8 from the output stage to the emitter of Q1. Bootstrapping is provided by capacitor C2 to maintain the high input impedance of Q1 while providing a low resistance bias source at its base.



SCHEMATIC OF PCA-1

AUDIO AMPLIFIER MEASUREMENTS

The power of audio amplifiers may be specified in a number of ways - - such as "RMS Power", "Music Power", etc. This quite often leads to confusion when prototypes are evaluated in the field. To help establish correlation, we will outline our measurement procedures along with some explanation of where problems can arise.

POWER

All Amperex amplifiers (prototypes or production units) are measured and specified as delivering a stated amount of continuous sine wave power into a specified load resistance at a specified level of distortion. In Class "B" power amplifiers, the drain on the power supply is a function of the power being delivered to the load - - as opposed to Class "A" amplifiers, where the drain is almost continuous. As a result, the power supply voltage under drive conditions depends upon the regulation (or impedance) of the power supply. Since the relationship for power is $\frac{(E)^2}{R}$ a slight change in E can result in substantial changes in power. To eliminate confusion, we have found it best to always specify the power with a regulated supply, and then where applicable include a IHFM power measurement as well, with a typical, practical supply.

The actual power measurements made in our application lab are made as follows:

- a.) The power supply voltage is measured across the power supply filter capacitor with a 1% meter. (The power supply has 0.005% regulation and has 0.2 ohm output impedance at 20Kc.)
- b.) A 1% (non-inductive) load resistance is used with dissipation capabilities of at least 5 times the power being measured.
- c.) The AC (RMS) voltage is measured across this load resistor with a 1% VTVM (Ballantine 310-A) and the power is then calculated (rather than measured) on a watt-meter.

DISTORTION

Most of our amplifiers are rated for power output at 10% harmonic distortion at 1 Kc.

Our Hi-Fi designs are usually rated for power output at 1% at 1 Kc with additional measurements at 20 cps, 100cps, 10 Kc and 20 Kc. We also usually supply a "power-bandwidth" measurement which shows the power vs. frequency as a function of distortion.

SENSITIVITY & INPUT impedance are usually indicated as "worst-case" with the unlikely combination of low-limit transistors in all sockets.

TEMPERATURE RANGE

All designs are checked out under worst-case conditions which include:

- a.) 10% high line voltage (with nominal equal to 115 Volts).
- b.) Highest beta transistors.
- c.) Ambients:
 - 1.) Thermistor stabilized designs to 60°C
 - 2.) Non-thermistor stabilized designs to 40°C.
- d.) Worst-case sine wave dissipation, approximately 40% of the sine wave clipping power.

(NOTE: This provides much more severe conditions than will be encountered in normal speech or music applications. If compromises are made to effect economies without affecting reliability in the actual application - - we will clearly indicate that these designs are "music-speech" stable, rather than "continuous sine with regulated supply" stable. Obviously, the consumer rarely listens to continuous sine wave signals, with regulated power supplies at high line voltages and high ambients simultaneously!)

SUMMARY OF ATTACHED APPLICATION CIRCUITS

1) 2 WATT COMPLEMENTARY AMPLIFIER PCA-1-14*

This low cost circuit provides 2 watts output when driven from a crystal cartridge. It features very high stability and reliability along with a low operating temperature and compact size.

2) 1 WATT COMPLEMENTARY AMPLIFIER PCA-1-9*

This circuit provides 1 watt output from a 9 volt battery or power supply. It features low battery drain along with a highly reliable and compact circuit without using any transformers.

3) LOW COST 1 WATT AMPLIFIER PCA-2-14*

This low cost circuit provides one watt output with the least number of components. It uses TO-1 output transistors which are mounted with a heat sink clip provided by Amperex. Speaker is 12 or 16 ohms.

4) 4 WATT COMPLEMENTARY AMPLIFIER PCA-3B-18-1*

This amplifier provides 4 watts output per channel from a crystal cartridge. It has bass and treble controls as well as loudness and balance controls. The amplifier is temperature stabilized by a thermistor and contains a low noise input transistor.

5) 2 WATT HIGH GAIN AMPLIFIER PCA-4-14*

This amplifier provides 2 watts output when driven by a ceramic cartridge. This unit may also be used with a tuner or tape input. It has an optional tone control which provides a treble cut.

6) 1 WATT HIGH GAIN AMPLIFIER PCA-4-9*

This circuit provides 1 watt output from a 9 volt battery with a ceramic cartridge input. It features a high gain circuit which allows an A.M. tuner to be used with it.

7) 2 WATT STEREO AMPLIFIER PCA-5A-14*

This amplifier provides 2 watts output per channel when driven by a crystal cartridge. This is a stereo version of PCA-1-14 with a tone control added.

8) 10 WATT STEREO AMPLIFIER PCA-6A-25

This amplifier provides 10 watts output per channel when driven by a ceramic cartridge. The circuit has complete bass, treble, volume and balance controls along with a low noise input. The circuit is temperature stabilized with a thermistor.

9) 10 WATT STEREO AMPLIFIER PCA-6A-255CS

This amplifier is the same as the PCA-6A-25 with a separate preamp strip to allow mounting in compact phonographs.

10) 5 WATT AUTO RADIO CIRCUIT

This circuit uses the 2N4079 output transistors (small TO-3) 5 watts into a 3.2 ohm load. This circuit features a very stable D.C. bias circuit, (which is compensated for battery and temperature variations) as well as low battery drain.

11) 10 WATT COMPLEMENTARY SYMMETRY AMPLIFIER

This circuit uses the 2N4079 output transistors, which are in small TO-3 cases (diamond shape). The frequency response of this circuit is from 25Hz to 65KHz at -3db, with the low frequency response limited by the values of the electrolytic capacitors.

12) 8 WATT GUITAR AMPLIFIER

This complete amplifier circuit features a transformerless output circuit using a complementary design. This provides excellent frequency response (20Hz - 30KHz). The amplifier has full bass and treble controls along with tremolo rate and intensity controls. The tremolo circuit used allows 100% modulation with very low distortion.

13) 20 WATT HI-FI AMPLIFIER

This circuit features very low distortion together with wide frequency response and high power output. (Typically 1% distortion 100Hz to 10KHz at 20 watts). The output transistors, along with their complementary drivers are available in a matched package. This matching provides the four transistors with a gain variation of only ± 1 db from set to set! The output transistors are diffused germanium with an F_t of 20 MHz and are matched to each other for beta at 300 ma and 3 amps. The 4 transistor kit is available at less than the cost of competitive output pairs.

*Available from Amperex as complete assembly.

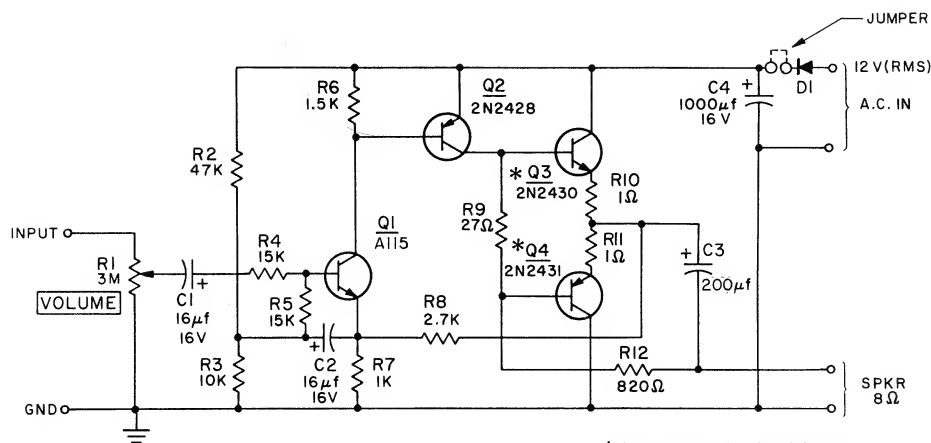
CIRCUITS AND DATA

(PAGES 8 - 28)

GENERAL SPECIFICATION FOR PCA-1-14

<u>Supply Voltage:</u>	14V DC (Regulated for measurement purposes)
<u>Load Impedance:</u>	8-16 ohms
<u>Input Impedance:</u>	600K ohms avg 220K ohms min
<u>Input Sensitivity for 1.9W:</u>	1.5V avg
<u>Power Output:</u>	1.9W @ 10% distortion @ 1 KHz @ 8 ohms 1.3W @ 10% distortion @ 1 KHz @ 16 ohms
<u>Idle Current:</u>	15 ma
<u>Maximum Current for 1.9W:</u>	210 ma
<u>Frequency Response:</u>	@ 1W @ 8 ohms 100 Hz - 40 KHz @ -3 db
<u>Power vs Total Harmonic Distortion:</u>	@ 1 KHz @ 8 ohms

0.1W	0.25%
0.5W	0.55%
1.0W	0.95%
1.5W	2.2%
2.0W	12.0%



* AVAILABLE AS A MATCHED
PAIR 2N4136.

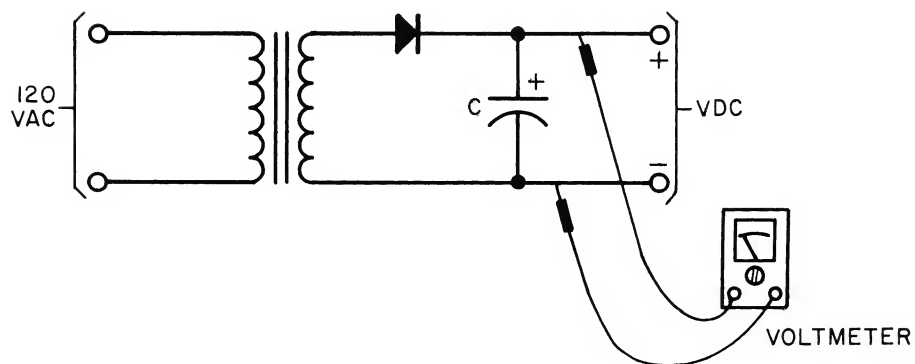
SCHEMATIC OF PCA -1-14

GENERAL SPECIFICATION FOR PCA-1-14 (Continued)

SUGGESTED POWER TRANSFORMER SPECIFICATIONS FOR PCA-1-14

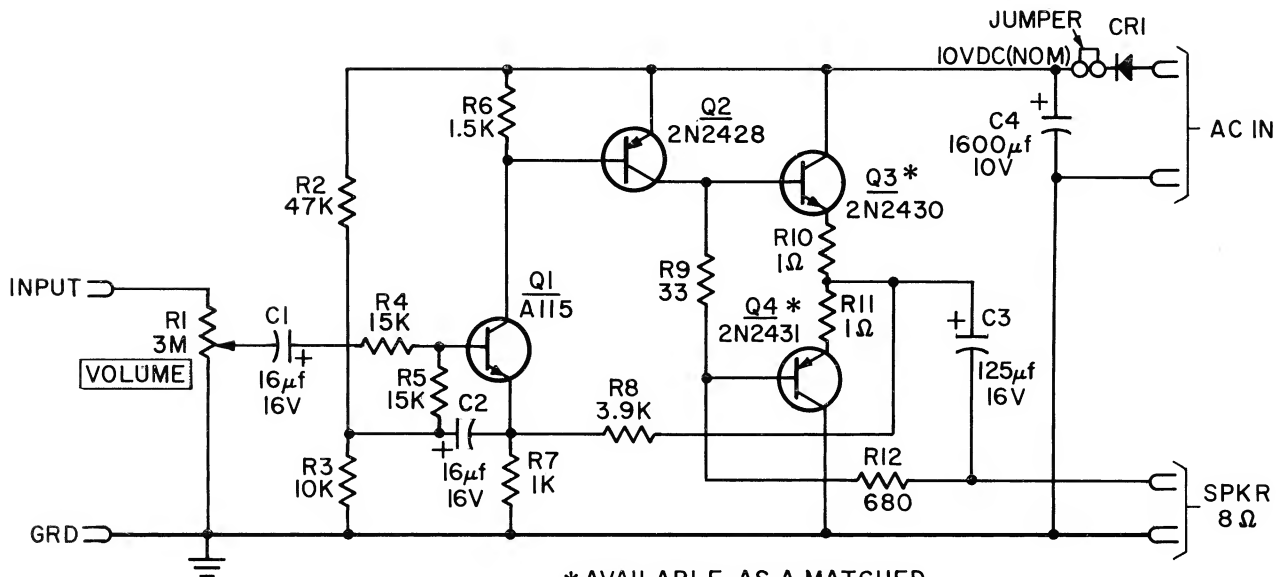
<u>Circuit Diagram:</u>	Half Wave
<u>Filter Capacitor:</u>	$C = 1000 \text{ uf}$
<u>Silicon Diodes:</u>	use 300 ma min
<u>DC Voltage Output:</u>	15V max @ 10 ma 13V min @ 200 ma

This power supply feeds a Class B amplifier so that temperature rise may be measured at 60% of full output.



GENERAL SPECIFICATION FOR PCA-1-9

<u>Supply Voltage:</u>	9V DC (Regulated for measurement purposes)
<u>Load Impedance:</u>	8-16 ohms
<u>Input Impedance:</u>	600K ohms avg 220K ohms min
<u>Input Sensitivity for 1.0W:</u>	0.7V avg 0.9V max
<u>Power Output:</u>	1.0W @ 10% distortion @ 1 KHz @ 8 ohms 0.7W @ 10% distortion @ 1 KHz @ 16 ohms
<u>Idle Current:</u>	13 ma
<u>Maximum Current for 1.0W:</u>	150 ma
<u>Frequency Response:</u>	@ 0.5W @ 8 ohms 100 Hz - 50 KHz @ -3 db
<u>Power vs Total Harmonic Distortion:</u>	@ 1 KHz @ 8 ohms 0.1W 0.2% 0.25W 0.4% 0.50W 0.72% 0.75W 1.3% 1.0W 10.0%



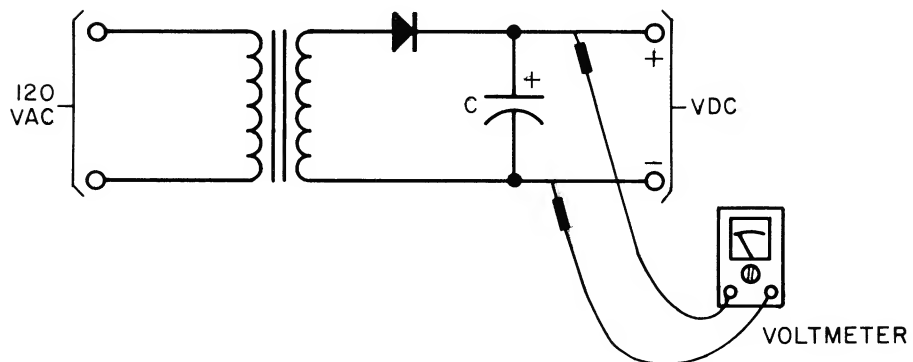
* AVAILABLE AS A MATCHED
PAIR 2N4136.

PCA-1-9

SUGGESTED POWER TRANSFORMER SPECIFICATIONS FOR PCA-1-9

<u>Circuit Diagram:</u>	Half Wave
<u>Filter Capacitor:</u>	$C = 1000 \text{ uf}$
<u>Silicon Diodes:</u>	use 250 ma min
<u>DC Voltage Output:</u>	10.5V max @ 10 ma 9.0V min @ 150 ma

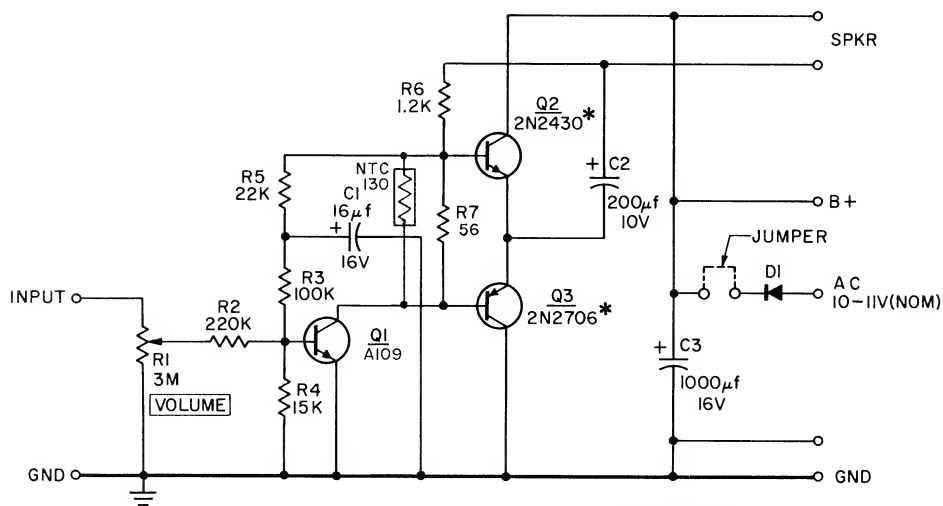
This power supply feeds a Class B amplifier so that temperature rise may be measured at 60% of full output.



GENERAL SPECIFICATION FOR PCA-2-14

<u>Supply Voltage:</u>	14V DC (Regulated for measurement purposes)
<u>Load Impedance:</u>	12-16 ohms
<u>Input Impedance:</u>	220K ohms min
<u>Input Sensitivity for 1W:</u>	2.8V avg 3.0V max
<u>Power Output:</u>	0.9W @ 10% distortion @ 1 KHz @ 12 ohms 0.8W @ 10% distortion @ 1 KHz @ 16 ohms
<u>Idle Current:</u>	8-12 ma
<u>Maximum Current for 1W:</u>	120 ma
<u>Frequency Response:</u>	@ 0.5W @ 16 ohms 80 Hz - 25 KHz @ -3 db
<u>Power vs Total Harmonic Distortion:</u>	@ 1 KHz @ 16 ohms

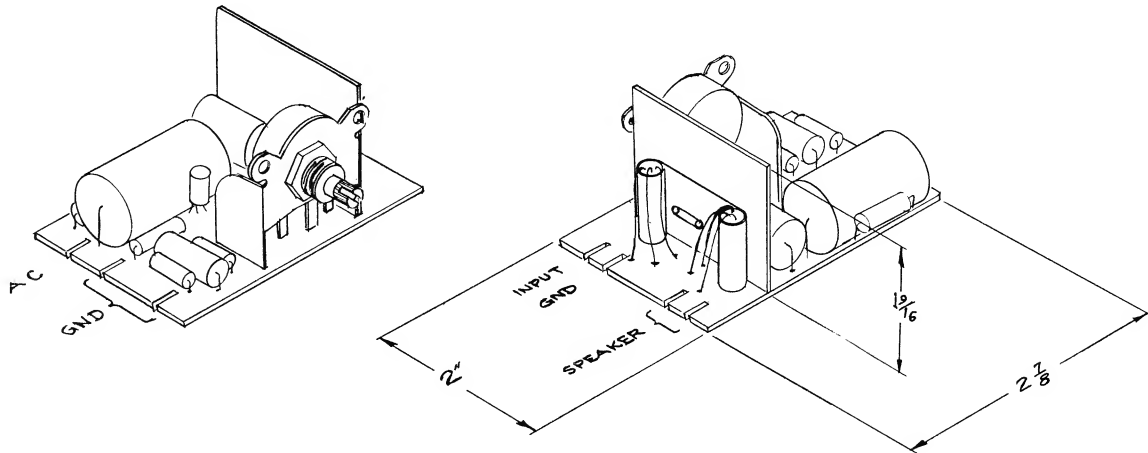
0.1W	3.0%
0.25W	5.0%
0.50W	7.0%
0.75W	9.0%
1.0W	12.0%



*AVAILABLE AS A MATCHED PAIR 2N2707.

SCHEMATIC OF PCA-2-14

GENERAL SPECIFICATION FOR PCA-2-14 (Continued)

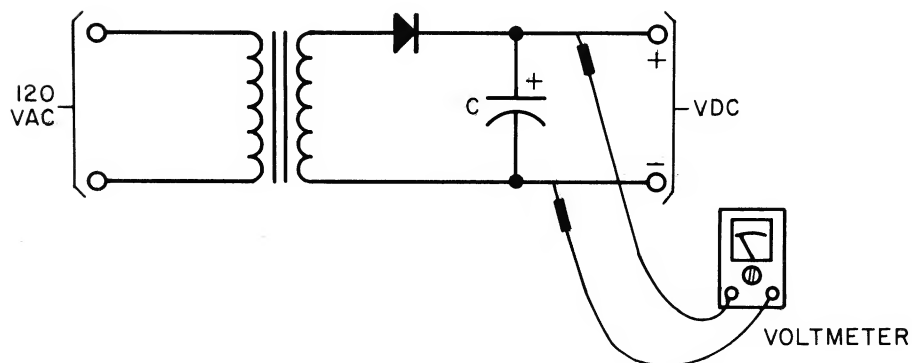


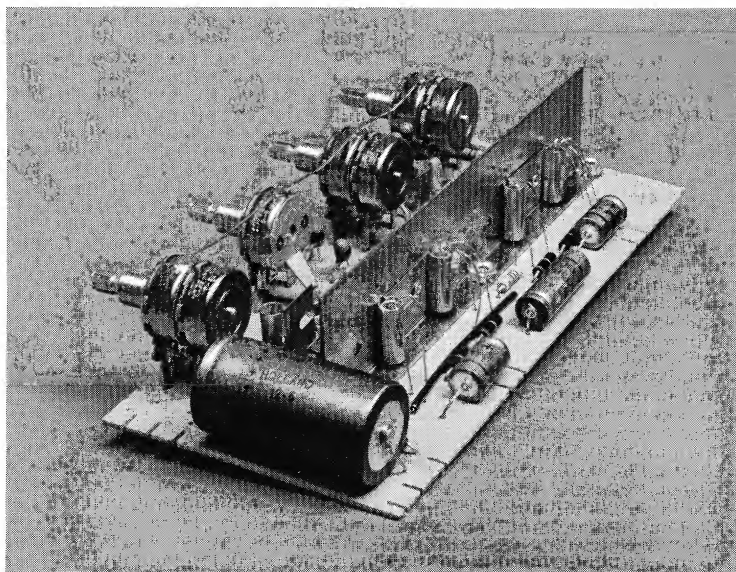
PCA-2-14

SUGGESTED POWER TRANSFORMER SPECIFICATIONS FOR PCA-2-14

<u>Circuit Diagram:</u>	Half Wave
<u>Filter Capacitor:</u>	C = 1000 uf
<u>Silicon Diodes:</u>	200 ma min
<u>DC Voltage Output:</u>	14.5V max @ 8 ma 12.0V min @ 120 ma

This power supply feeds a Class B amplifier so that temperature rise may be measured at 60% of full output.





GENERAL SPECIFICATION FOR PCA-3B-18-1

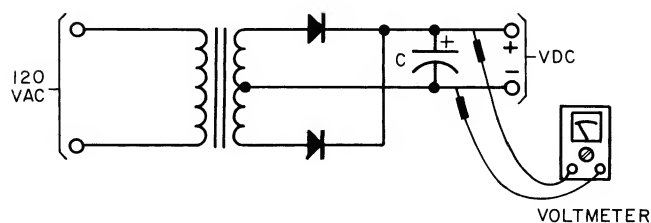
Supply Voltage:	18V DC (Regulated for measurement purposes)
Load Impedance:	8 ohms
Input Impedance:	1 megohm avg 300K ohms min
Input Sensitivity for 4.5W:	1.6 volts avg
Power Output:	4.5W @ 10% distortion @ 1 KHz @ 8 ohms
Idle Current:	12 ma
Maximum Current for 4.5W:	320 ma
Frequency Response:	@ 1W @ 8 ohms 45 Hz - 20 KHz @ -3 db
Tone Controls:	Treble + 6 db -15 db @ 10 KHz Base + 7 db - 12 db @ 100 Hz
Power vs Total Harmonic Distortion:	@ 1 KHz @ 8 ohms

0.1W	1.5%
0.5W	2.0%
1.0W	2.5%
2.0W	3.0%
3.0W	3.5%
4.0W	6.0%
5.0W	15.0%

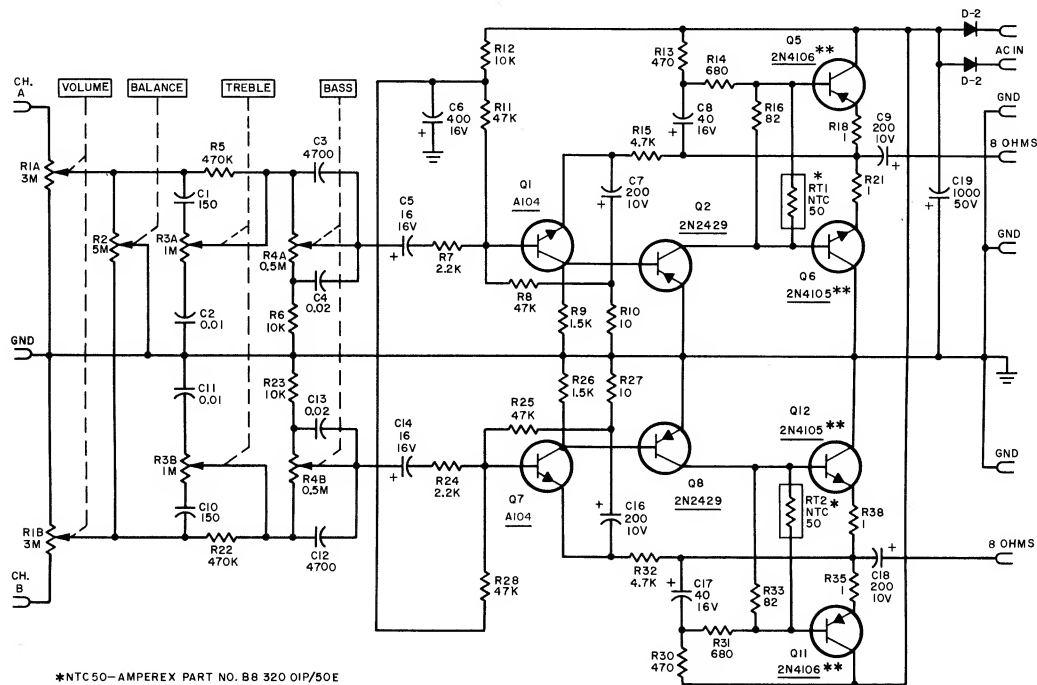
SUGGESTED POWER TRANSFORMER SPECIFICATIONS FOR PCA-3B-18-1

Circuit Diagram:	Full Wave Center Tapped Secondary
Filter Capacitor:	C = 1000 uf
Silicon Diodes:	500 ma min
DC Voltage Output:	19.5V max @ 40 ma 16.5V min @ 700 ma

This power supply feeds a Class B amplifier so that temperature rise may be measured at 60% of full output.

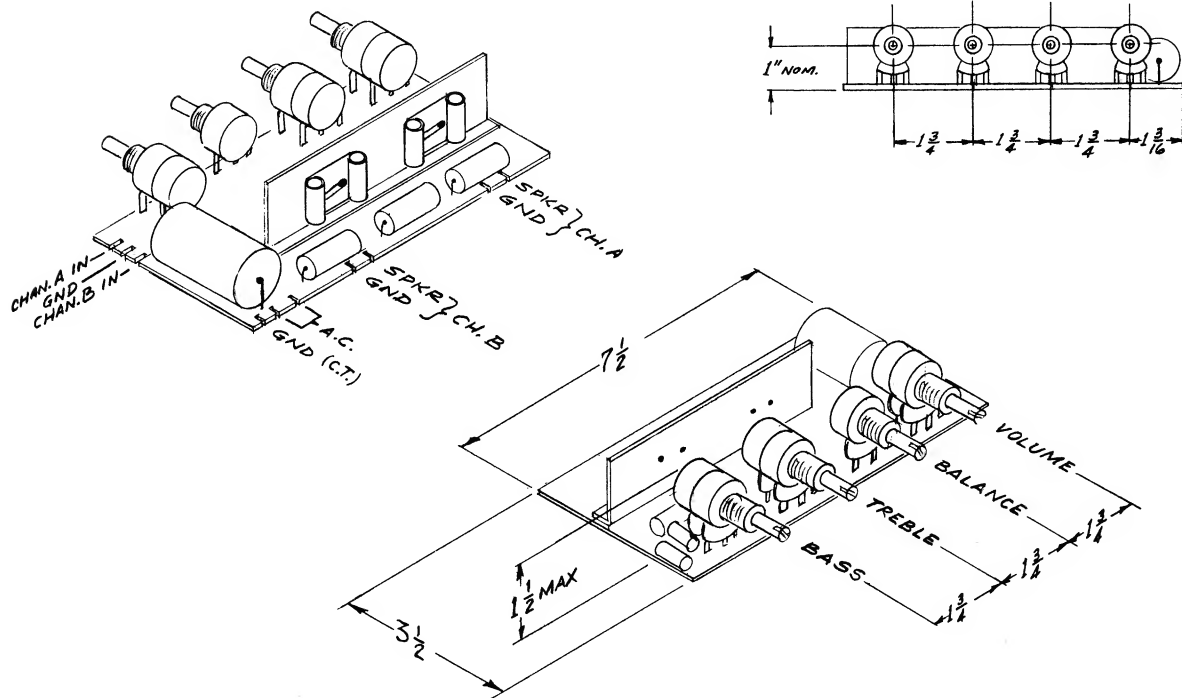


GENERAL SPECIFICATION FOR PCA-3B-18-1 (Continued)

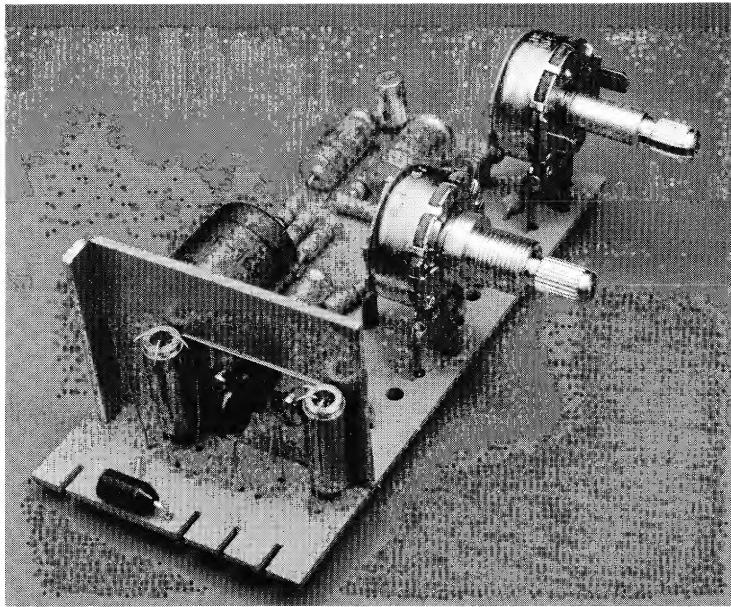


*NTC50- AMPEREX PART NO. B8 320 OIP/50E
 **2N4105 & 2N4106 ARE AVAILABLE AS A
 MATCHED PAIR (2N4107).
 ***PCA-3B-18-1 IS LATER VERSION OF PCA-3B-18

PCA-3B-18-1



OUTLINE DWG PCA-3B-18-1



GENERAL SPECIFICATION FOR PCA-4-14

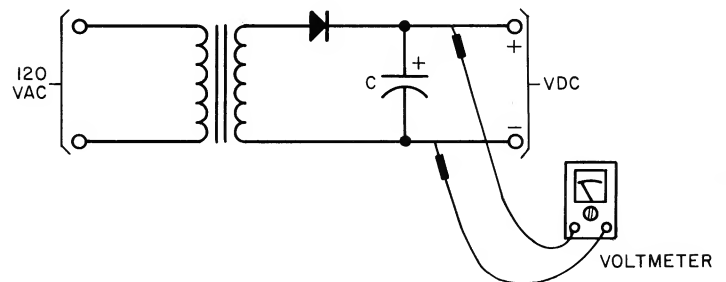
Supply Voltage:	14V DC (Regulated for measurement purposes)
Load Impedance:	8-16 ohms
Input Impedance:	25K ohms avg 20K ohms min
Input Sensitivity for 1.9W:	0.040V avg 0.045V max
Power Output:	1.9W @ 10% distortion @ 1 KHz @ 8 ohms 1.0W @ 10% distortion @ 1 KHz @ 16 ohms
Idle Current:	14 ma
Maximum Current for 1.9W:	240 ma
Frequency Response:	@ 1W @ 8 ohms 40 HZ - 18 KHz @ -3db
Tone Control: (optional)	Treble + 0 db -12 db @ 10 KHz
Power vs Total Harmonic Distortion:	@ 1 KHz @ 8 ohms

0.1W	1.0%
0.5W	2.7%
1.0W	3.5%
1.5W	5.2%
2.0W	12.0%

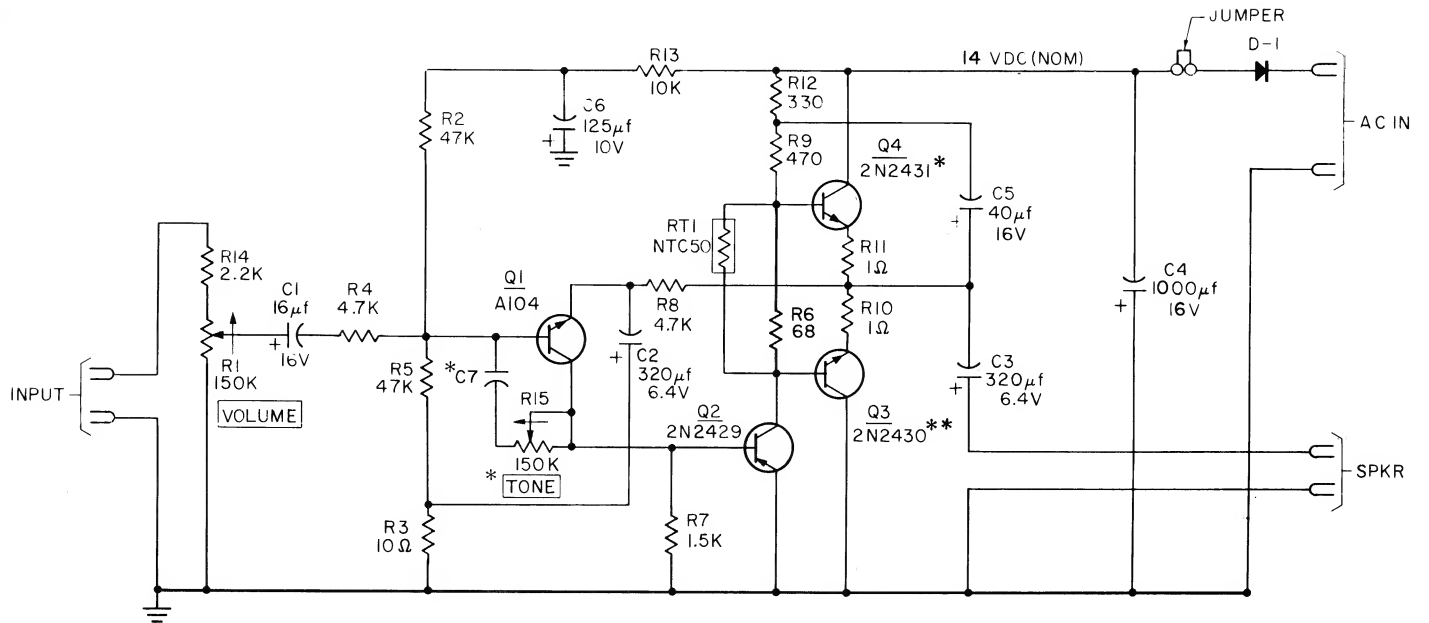
SUGGESTED POWER TRANSFORMER SPECIFICATIONS FOR PCA-4-14

Circuit Diagram:	Half Wave
Filter Capacitor:	C = 1000 uf
Silicon Diodes:	use 500 ma
DC Voltage Output:	14.5V max @ 12 ma 12.5V min @ 210 ma

This power supply feeds a Class B amplifier so that temperature rise may be measured at 60% of full output.



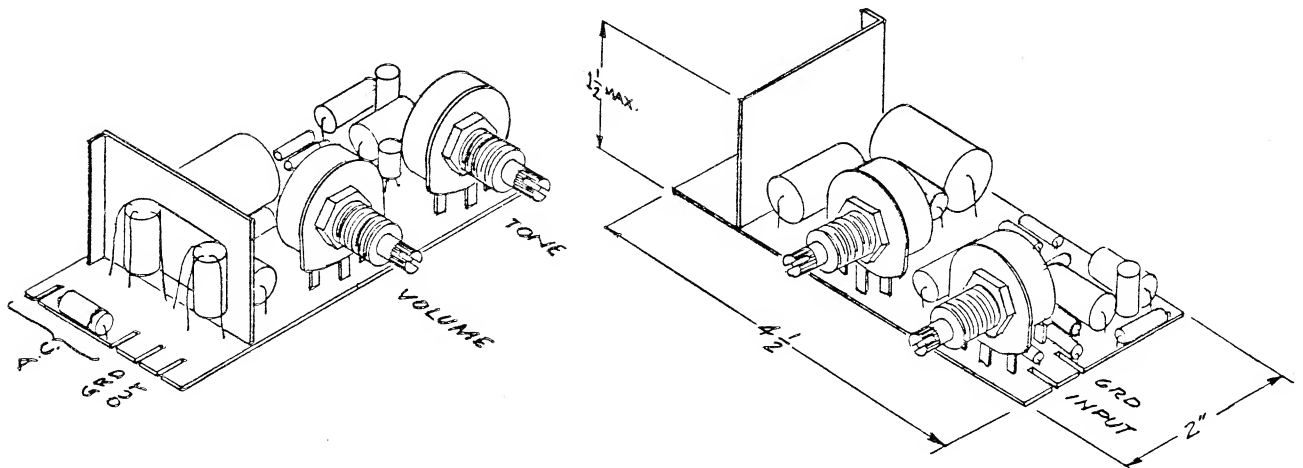
GENERAL SPECIFICATION FOR PCA-4-14 (Continued)



*TONE CONTROL CIRCUIT IS OPTIONAL

**AVAILABLE AS A MATCHED PAIR 2N4136.

PCA-4-14

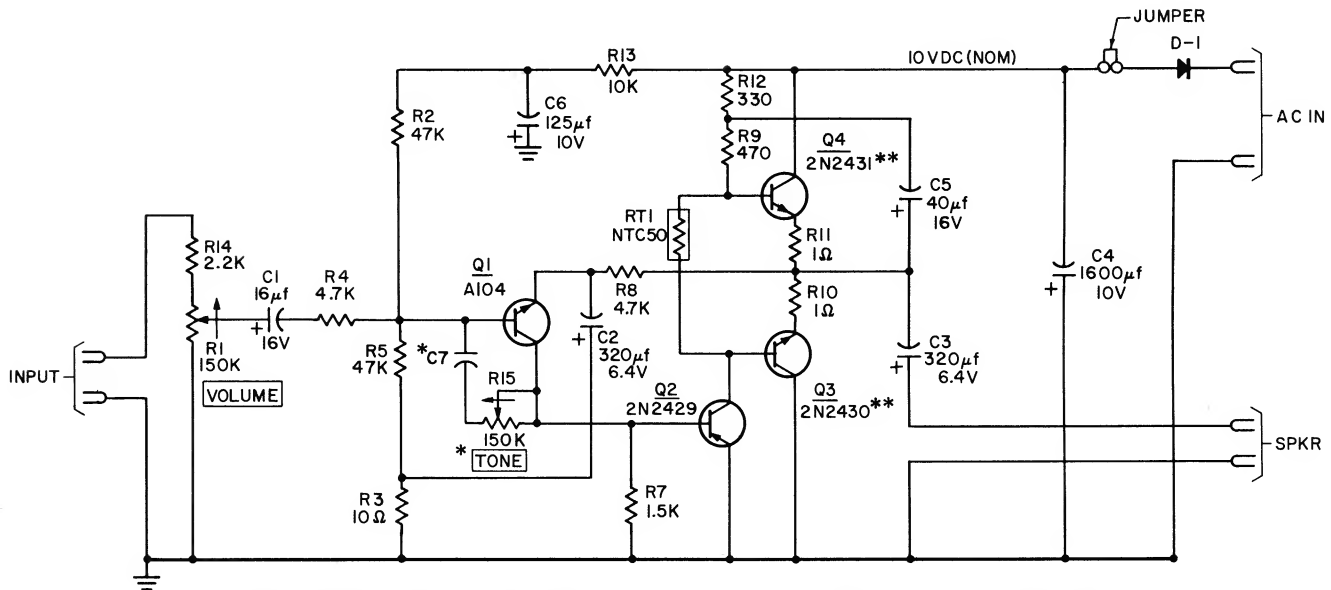


PCA-4-14

GENERAL SPECIFICATION FOR PCA-4-9

<u>Supply Voltage:</u>	10V DC (Regulated for measurement purposes)
<u>Load Impedance:</u>	8 ohms
<u>Input Impedance:</u>	25K ohms avg 20K ohms min
<u>Input Sensitivity for 0.92W:</u>	0.035V avg 0.040V max
<u>Power Output:</u>	0.92W @ 10% distortion @ 1 KHz @ 8 ohms
<u>Idle Current:</u>	10 ma
<u>Maximum Current for 0.92W:</u>	170 ma
<u>Frequency Response:</u>	@ 0.5W @ 8 ohms 50 Hz - 20 KHz @ -3 db
<u>Tone Controls: (optional)</u>	Treble + 0 db -12 db @ 10 KHz
<u>Power vs Total Harmonic Distortion:</u>	@ 1 KHz @ 8 ohms

0.1W	1.8%
0.5W	4.5%
0.75W	6.5%
1.0W	12.0%



*TONE CONTROL CIRCUIT IS OPTIONAL

**AVAILABLE AS A MATCHED PAIR 2N4133.